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Biological Studies of *Goetheana parvipennis* (Gahan) (Hymenoptera: Eulophidae), an Imported Parasitoid, in Relation to the Host Species *Heliothrips haemorrhoidalis* (Bouché) (Thysanoptera: Thripidae)

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Abstract.—Observations were conducted on the biology of the greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché), and the imported parasitoid, *Goetheana parvipennis* Gahan. Time required for the development of the unparasitized and parasitized host larvae was recorded. Parasitism extended the second host larval instar and the prepupa, and prevented molting of the host to the pupa. Developmental time of the host and the parasitoid was similar. Temperatures ranging from 21 to 24°C appeared close to the optimum for the parasitoid in terms of development, progeny production, especially on avocado leaves, and percentage of adult emergence.

The greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché), is a serious pest on avocados in California (Boyce and Mabry, 1937; Ebeling and Pence, 1953; Ebeling, 1959). Only one indigenous parasite, *Megaphragma mymaripenne* Timberlake, is known for this thrips in California (Ebeling, 1959; McMurtry, 1961; McMurtry and Johnson, 1963). Although *M. mymaripenne* attacks a considerable percentage of greenhouse thrips eggs, its ability to control thrips populations is questionable (Ebeling, 1959; Hessein and McMurtry, 1988).

The introduction and establishment of additional parasitoids seemed necessary for more effective biological control of the greenhouse thrips. The eulophid, *Goetheana parvipennis* Gahan, parasitizes greenhouse thrips as well as the red-banded thrips or the cacao thrips, *Selenothrips rubrocinctus* (Giard). *Goetheana parvipennis* was introduced from West Africa to Trinidad in 1935, and became established there as well as in other parts of the Caribbean (Callan, 1943; Bennett and Baranowski, 1982). In 1962, *G. parvipennis* was introduced to California from Trinidad (McMurtry and Johnson, 1963) and again in 1982 from the Bahamas. Although the parasitoid has been recovered from one release site, permanent establishment cannot be documented at present.

This paper reports on preliminary studies on the biology of *G. parvipennis* in relation to that of the greenhouse thrips.

Materials and Methods

Observations on developmental biology of G. parvipennis.—An avocado leaf was placed dorsal side up on a foam pad in a stainless steal pan containing distilled

Figure 1. Rearing unit for the parasitoid, *G. parvipennis* Gahan, with the cover on.

water (McMurtry and Scriven, 1965). The leaf was bordered by a moistened strip of Cellucotton®, 1 cm wide. A circle, 5 cm in diameter, was created on the leaf surface by a similar moistened strip of cellucotton. Two hundred early second-instar thrips larvae, reared on orange fruits, were placed inside this circle. Six fertilized adult females and five adult males of the parasitoid were then placed on the same avocado surface with the host larvae. The surface of the circle was covered by a clear plastic, 135-ml food container. For ventilation, four holes were made in the container and covered by cheese cloth. Searching, ovipositing time, and frequency of oviposition of the parasitoids were observed through the plastic. The parasitoids and host larvae were left for 3 days, after which the parasitoids were removed. Twenty of the host larvae were then placed singly in 1-cm^2 areas formed by moistened thin cellucotton strips on two avocado leaves. The remaining host larvae were placed in groups of three on areas, each 2 cm^2, created as above, on other avocado leaves. When leaves showed signs of deterioration, the host larvae were moved to fresh ones. After the parasitoids formed black pupae, they were transferred to vials, either singly or in groups of three, as above. Behavior

Figure 2. An adult parasitoid *G. parvipennis* ovipositing laterally in the first part of the host abdomen.

of the parasitized host, developmental time, morphology and emergence of the pupae of the parasitoid were observed. Studies were conducted in the laboratory, at 21.1–24.4°C and 20–28% RH.

Effect of temperature on developmental time, progeny production, sex ratio and longevity of G. parvipennis.—To study the effect of temperature on developmental time, progeny production and sex ratio, ripe Valencia oranges were placed singly inside inverted 1-liter plastic food containers (Fig. 1) to delay desiccation of the orange. For ventilation, two circles 5 cm in diameter were cut in the side of the container and covered by cheese cloth glued to the container. Each orange was supplied with 200 host larvae and 10 fertilized females and 10 males of the parasitoid. Four replicates were used for each of three temperatures (17.8, 22.2 and 29.4°C) maintained in small, controlled-temperature cabinets.

To determine longevity in the absence of the host, adult females or males of the parasitoid were placed in groups in small plastic vials, where a streak of honey

Figure 3. Emergence of mature parasitoid larva anteriorly from the host.

was supplied. The vials were covered with cloth-ventilated plastic covers. Water was supplied daily by placing a small piece of cotton, soaked in distilled water, on top of the cloth. Besides the three temperatures used before, the effect of 13°C was studied using a similar temperature cabinet.

Developmental period and adult longevity of H. haemorrhoidalis.—Five ripe Valencia oranges were placed singly under 1-liter plastic food containers (Fig. 1). On each orange, an 8 × 4-cm area was delineated by Tanglefoot®. This area was subdivided into eight spaces (2 × 2 cm) by Tanglefoot®. A single adult thrips was placed in each space. Forty adults were allowed to oviposit for 48 hr and then removed. After the eggs hatched, all but two of the resulting larvae were removed. The length of the incubation period, each instar and the longevity of the adults were determined by daily observations. During the active stages of the thrips, oranges were replaced by fresh ones every 10 days. Studies were conducted in small temperature cabinets (Platner et al., 1973) at 23.3°C, 15–60% RH, and 12:12 L:D photoperiod.

Figure 4. Swollen host thrips with single *G. parvipennis* larva (right) and superparasitized thrips (left) with two larvae of the parasitoid.

Results and Discussion

Observations on developmental biology of G. parvipennis.—General observations indicated that the adult females usually preferred the early second-instar thrips for oviposition, although sometimes first or late second instars also were stung. The prepupa of the host occasionally was parasitized but the parasitoid did not complete its development and the host always died before reaching the pupal stage. Entwistle (1972), in his review, stated that *G. parvipennis* females will attack nearly mature host larvae but reproduce best in younger stages. The

Table 1. Time required for development of parasitized *H. haemorrhoidalis* and its parasite, *G. parvipennis,* at 21.1–24.4°C.

Stage	No. of individuals	Estimated required time in days		
		Avg.	Min.	Max.
2nd to 3rd instar (prepupa)				
Unparasitized host	28	4.7	3	5
Parasitized host	20	11.0	10	12
Host 3rd instar (prepupa) to parasite pupa	20	4.7	3	6
Parasite pupa darkening to adult emergence	15	12.5	12	13
Total time required for parasite development[1]				
a. Males	13	27.8	27	29
b. Females	85	28.3	27	29

[1] Oviposition to adult emergence.

Table 2. Time required for adult emergence, percentage emergence, sex ratio and progeny production rate/female of *G. parvipennis* at two different temperatures.

Temperature RH%	Time to adult emergence (days)			% adult emergence			Sex ratio (♀:♂)			No. of pupae formed		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
22.2°C[1] 10–65%	31.6	31.0	33.0	75.5	50.7	83.1	1.99:1	1.32:1	2.45:1	10.10	7.00	13.00
29.4°C[1] 20–40%	20.3	17.0	26.0	59.1	42.9	63.2	4.83:1	4.00:1	6.00:1	3.43	1.40	5.70

[1] Four replicates, each with 10 fertilized females and 10 males.

Table 3. Longevity of *Goetheana parvipennis* Gahan at different temperatures.

Temperature (°C)	No. of adults used	Number of days		
		Avg.	Min.	Max.
12.8	46 ♀	11.3	3	27
	27 ♂	21.7	2	46
17.8	61 ♀	16.6	2	36
	24 ♂	20.8	2	42
22.2	34 ♀	9.3	4	20
	36 ♂	12.4	4	28
29.4	44 ♀	1.1	2	6
	31 ♂	2.8	2	15

adult female inserted its ovipositor laterally in the anterior part of the host abdomen (Fig. 2). Oviposition time ranged from 23 to 48 sec. Stung hosts were motionless for a few seconds. Up to 25 host larvae were stung by a single female in a period of 10–25 min, alternating oviposition with short intervals of cleaning the ovipositor. Parasitized larvae molted to the prepupal stage. Dohanian (1937) stated that the development of the parasitoid larvae is at first very slow, until the host develops nearly to the prepupal stage. After reaching the prepupal stage, the host was motionless and slightly swollen. The end of the abdomen darkened 2–3 days later. When the parasitoid completed its larval development, it emerged from the host anterior through a slit between the prothorax and the mesothorax (Fig. 3). The pupae of the parasitoid were first whitish in color, but in a few hours turned black, with the shrunken host integument beneath. Superparasitism occurred occasionally, where two larvae developed in one host (Fig. 4). In such cases, one of the pupae was usually atrophied, while the other completed development.

The parasitized second-instar larvae took an average of 11 days to reach the prepupa stage, compared to only 4.7 days for unparasitized second instars (Table 1). After the host thrips reached the prepupa stage, the parasitoid took an average of 4.7 days to emerge from the host and pupate. Its position was either perpendicular or parallel to the host integument. Adult parasitoids emerged in 12–13 days after the pupae darkened. Total developmental time from oviposition to adult emergence averaged 27.8 days for males and 28.3 days for females at 21.1–24.4°C. Symptoms of parasitism appeared about 14 days after stinging. Dohanian (1937) stated that the pupa of *G.* (=*Dasyscaphus*) *parvipennis* is jet black and shining, and that its duration is 10 or 11 days until the emergence of the adults. Under laboratory conditions, he found that its life cycle ranges from 17 to 21 days.

Mean progeny production of *G. parvipennis,* where avocado leaves were used as the substrate, was 25.3/female (for the six fertilized females used in the beginning of the experiment). Mean percentage emergence was 64.47% and the sex ratio was 6.54 ♀:1 ♂.

Effect of temperature on development, sex ratio, fecundity and longevity of G. parvipennis.—At 17.8°C, the parasitoid did not reach the pupal instar. The average developmental time was 31.6 and 20.3 days at 22.2°C and 29.4°C, respectively.

Table 4. Length of developmental stages of *Heliothrips haemorrhoidalis* (Bouché) in days at 23.3°C.

Stage	Number of individuals	Number of days		
		Avg.	Min.	Max.
Egg	42	18.69	15	21
1st larva	42	3.42	3	4
2nd larva	28	4.66	3	5
Prepupa	26	1.60	1	3
Pupa	24	2.60	2	3
Total		30.97	24	36

Though the developmental time was short at 29.4°C, adult emergence was low, averaging only 59.1%. At 22.2°C, emergence was 75.5% (Table 2). A higher sex ratio occurred at 29.4°C (average of 4.8 ♀:1 ♂) than at 22.2°C (average of 2.8 ♀:1 ♂) (Table 2).

A higher rate of progeny production occurred at 22.2°C (10.1) than at 29.4°C (3.4) (Table 2). However, the average of 10.1 progeny/female was much lower compared to the rate on avocado leaves, where it was 25.3 progeny/female when six fertilized females were used. This last rate was usually the case in the rearing units of the parasitoid on avocado leaves, suggesting that the host plant might have an effect on progeny production rate and sex ratio for *G. parvipennis*. Dohanian (1937) also obtained about 25 progeny/female when culturing *G. parvipennis* on cacao thrips. Adamson (1936) stated that up to 70 progeny have been obtained from a single female *G.* (=*Dasyscaphus*) *parvipennis* in the laboratory in Trinidad.

Longevity of the adult parasite was considerably reduced at higher temperatures (Table 3). Mean longevity of males exceeded that of females at all 4 experimental temperatures.

The data in Tables 1–3 suggest that temperatures of 21.1–24.4°C are near the optimum range for development and reproduction of *G. parvipennis*. Low temperature, such as 17.8°C, or high temperature, such as 29.4°C, are not favorable. From the above studies, it is obvious also that this parasitoid, coming from the Bahamas, might be more successful in tropical areas, where temperature ranges are moderate.

Developmental period and adult longevity of H. haemorrhoidalis.—The length of the developmental stages of *H. haemorrhoidalis* is summarized in Table 4. The total developmental time averaged 30.97 days, including an incubation period of 18.69 days at 23.3°C. The longevity of the adults ranged from 20 to 58 days, with an average of 40.6 days. One adult lived to 89 days. Rivnay (1935) reported that the total developmental time of the greenhouse thrips was 42 days at 23°C, 36 days at 25°C, and 30.8 days at 28°C. He found that the longevity of individuals reared in test tubes was 40 days at 29–30°C, 55 days at 25–27°C, and 110 days at 18–20°C. At similar temperature ranges, he found that the individuals reared on plants did not live as long as those reared on leaf tissue in test tubes.

Literature Cited

Adamson, A. M. 1936. Progress report on the introduction of a parasite of the cacao thrips from the Gold Coast to Trinidad, B.W.I. Trop. Agric. Trin., 13:62–63.

Bennett, F. D., and R. M. Baranowski. 1982. First record of the thrips parasite *Goetheana parvipennis* (Gahan) (Eulophidae: Hymenoptera) from the Bahamas. Fla. Entomol., 65(1):185.

Boyce, A. M., and J. Mabry. 1937. The greenhouse thrips on oranges. Calif. Citrogr., 33(1):19–20, 28–29.

Callan, E. M. 1943. Natural enemies of the cacao thrips. Bull. Entomol. Res., 34:313–321.

Dohanian, S. M. 1937. Life history of the thrips parasite *Dasyscapus parvipennis* Gahan and the technique for breeding it. J. Econ. Entomol., 30:78–80.

Ebeling, W. 1959. Subtropical fruit pests. Univ. Calif. Div. Agr. Sci., 436 pp.

Ebeling, W., and R. J. Pence. 1953. Avocado pests. Calif. Agr. Exp. Stn. Cir., 428:1–35.

Entwistle, P. F. 1972. Thysanoptera. In pests of cocoa. Trop. Sci. Series, Longmans, pp. 333–362.

Hessein, N. A., and J. A. McMurtry. 1988. Observations on *Megaphragma mymaripenne* Timberlake (Hymenoptera: Trichogrammatidae), an egg parasite of *Heliothrips haemorrhoidalis* (Bouché) (Thysanoptera: Thripidae). Pan-Pac. Entomol., 64:250–254.

McMurtry, J. A. 1961. Current research on biological control of avocado insect and mite pests. Yearbk. Calif. Avocado Soc., 45:104–106.

———, and H. G. Johnson. 1963. Progress report on the introduction of a thrips parasite from the West Indies. Yearbk. Calif. Avocado Soc., 47:48–51.

———, and G. T. Scriven. 1965. Insectary production of phytoseiid mites. J. Econ. Entomol., 58: 282–286.

Platner, G. R., G. T. Scriven, and C. E. Braniger. 1973. Modification of a compact refrigerator for bio-ecological studies under controlled physical parameters. Environ. Entomol., 2(6):1118–1120.

Rivnay, E. 1935. Ecological studies of the greenhouse thrips, *Heliothrips haemorrhoidalis* Bouché in Palestine. Bull. Entomol. Res., 26:267–278.